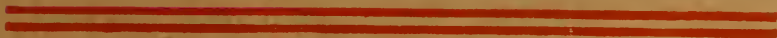


**The** NEW YORK  
IMPROVEMENT  
and TUNNEL  
EXTENSION of  
THE PENNSYLVANIA  
RAILROAD . . . . .

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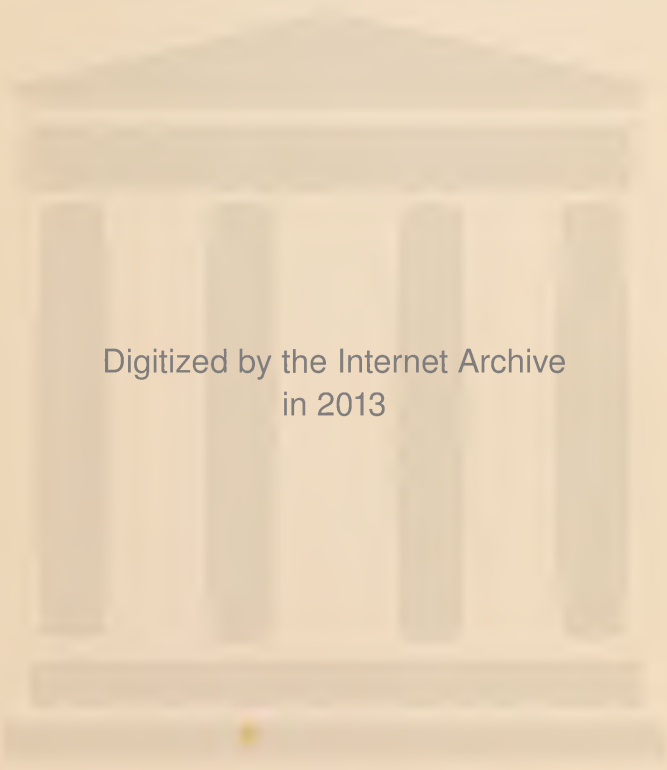
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*Pennsylvania Station—  
Seventh Avenue Facade*

**The** NEW YORK  
IMPROVEMENT  
and TUNNEL  
EXTENSION of  
THE PENNSYLVANIA  
RAILROAD . . . . .

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ISSUED OCTOBER, 1910

PHILADELPHIA, PENNSYLVANIA

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EVERY  
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P38  
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ALEXANDER · JOHNSTON · CASSATT  
PRESIDENT · PENNSYLVANIA · RAILROAD · COMPANY  
1899-1906

WHOSE · FORESIGHT · COURAGE AND ABILITY · ACHIEVED  
THE · EXTENSION · OF · THE · PENNSYLVANIA · RAILROAD · SYSTEM  
INTO · NEW · YORK · CITY

*THE*  
PENNSYLVANIA RAILROAD'S  
NEW YORK  
IMPROVEMENT

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**T**HE Pennsylvania Station in New York City, at Seventh Avenue and Thirty-second Street, now completed, covers more territory than any other building ever constructed at one time in the history of the world. The Vatican, the Tuileries, the St. Petersburg Winter Palace, are larger buildings, but they have occupied centuries in their construction. The Pennsylvania Station is unique, covering as it does eight acres of ground, with exterior walls extending approximately one-half of a mile, all told, and having been erected in less than six years' time.

This Station is not only the largest structure of its kind in the world, but it epitomizes and embodies the highest development of the art of transportation. Every practicable convenience, the most ingenious of mechanical and electrical inventions, every safeguard against danger—all, in fact, that has so far been learned in railway transportation and station perfection, has been availed of for the benefit of every passenger, no matter whether he is to take a short ride to Long Island or a two thousand mile trip to the West.

While the cost of the improvement represents a greater expenditure than was ever before incurred by a private corporation for a single undertaking, nevertheless the outlay was required to unite the principal parts of the thickly populated area in and around New York City, and to provide unsurpassed facilities, in the very heart of the city, for reaching the entire country.

The idea of tunneling Hudson and East Rivers for an entrance into New York City did not evolve suddenly. It was the logical result of long-studied plans in which Mr. Alexander Johnston Cassatt, the late President of the Company, participated from the beginning, and an entrance into New York City was decided upon only when the Executive Officers and Directors of the Company realized that it had become an absolute necessity.

After the Company in 1871 leased the United Railroads of New Jersey, which terminate in Jersey City, the Officers of the Railroad looked longingly toward New York City. They wanted a station there, but they were confronted both by the great expense of such an undertaking, as well as the lack of a feasible plan, for at that time the engineering obstacles seemed to be insurmountable. The panic of 1873 made it impossible to promote any large extension or to become actively engaged in a proposition from which no immediate return could be shown;

but from this time, and particularly in 1874, when the Hudson Tunnel scheme, now completed and in operation under the control of the Hudson Companies, was first started, the problem was considered. In 1884, a proposition was entertained to build the "North River Bridge" across the Hudson River, with a span almost twice that of the Brooklyn Bridge. The panic of that year, however, put a damper on all new undertakings.

In 1892 the subject was again revived, and after careful surveys had been made, a number of different propositions were submitted, but the silver panic of 1893 prevented the adoption of any particular plan.

In 1900 the control of the Long Island Railroad was acquired by the Pennsylvania Railroad Company, and it then became desirable that the Pennsylvania should have a physical connection with the Long Island Railroad. As the other railroad lines using ferries to carry passengers into New York City did not approve of the construction of the Hudson River Bridge, and as it was impossible to obtain a charter for a bridge to be used exclusively by a single company, a tunnel scheme was adopted by the Pennsylvania Railroad. The improvement in methods of tunnel construction, the use of electric power in tunnels, and the favorable condition of business, were the principal considerations which led to the adoption of the plan of construction which has since been carried out.

## II

In 1901 the Pennsylvania Railroad was employing ferries to land its passengers in New York City just as it did in 1871, when it first leased the United Railroads of New Jersey.

Railroads on the western bank of the Hudson River opposite New York City carried, in 1886, nearly 59,000,000 people. In 1890 they carried over 72,000,000, in 1896 more than 94,000,000 and in 1906 about 140,000,000 people.

In 1890 the population gathered within a circle of 19 miles radius, with City Hall, Manhattan, as the center, was 3,326,998; in 1900 it was 4,612,153, and five years later it was 5,404,638, an increase in ten years of 38 per cent. In 1913 it is estimated that the population of this territory will approximate six million people, and in 1920 eight million.

These startling figures, and what they meant in transportation needs, in addition to the serious problem of providing corresponding freight facilities, were considered when the Pennsylvania Railroad was contemplating entering New York City. It was evident that one of the greatest transportation problems in history was rapidly evolving, and it was only by quick action that the Railroad could prepare to cope with it.

With the traffic in and out of New York City growing more rapidly than it had during any period in the last twenty years, the question confronting



*Pennsylvania Station—  
Detail of Main Entrance on  
Seventh Avenue*



*Pennsylvania Station—*

*Detail of Driveway Entrance,  
Thirty-first Street and Seventh  
Avenue*

the Management of the Railroad was whether the volume of this traffic was such as to warrant any other method of transportation than ferries for crossing North and East Rivers. The action taken by the Pennsylvania Railroad shows how it met this situation, and the result is the New York Station and Tunnel Extension.

### III

There were many reasons for the construction of this great improvement. The Company desired to provide for the future by enlarging the present facilities for freight and passenger traffic, because of the continuous growth in this traffic. To accomplish this before the cost became almost prohibitive, or the task impossible because of the construction of other underground transportation lines, meant that no time should be lost.

It was the Company's plan to run its passenger trains into a centrally located station in the city of New York, instead of one on the western bank of the Hudson River; to give rapid transit from the residential sections of Long Island, and to offer to Newark and other cities in New Jersey, direct and quick access to New York City, and to the resorts on Long Island beaches.

It was considered essential to provide an all-rail connection between the South and West on the one

hand, and New England and the East on the other. The Company desired to give to the Boroughs of Brooklyn and Queens, with their population of over 1,500,000, direct railroad connections to and from the New England, Southern and Western States, and to supply freight facilities with similar connections in these Boroughs, with freight stations suitably located to develop their commercial interests.

It was planned to provide additional freight facilities, and, by the use of the Long Island Railroad, to shorten the water transportation trip for the New England traffic across New York Harbor from twelve to three and four-tenths miles.

The Company considered it its duty to obtain a proper share of the golden future by judicious expenditures in a territory having abundant promise, whether viewed from the growth of traffic in the past, or the outlook for the future.

#### IV

Built after the Roman Doric style of architecture, the New York Station of the Pennsylvania Railroad covers the entire area bounded by Seventh and Eighth Avenues and Thirty-first and Thirty-third Streets. The depth of the property on both streets is 799 feet  $11\frac{1}{4}$  inches, and the length of the building is 788 feet 9 inches, thus allowing for extra-wide sidewalks on both side streets and avenues. The walls extend 430



*Pennsylvania Station—*

*Seventh Avenue Facade looking  
North from Thirty-first Street*



*Pennsylvania Station—  
Detail of Thirty-third Street  
Entrance to Main Waiting  
Room*

feet 6 inches from Thirty-first Street to Thirty-third Street, the Seventh Avenue facade signaling the main entrance.

While the facades of the station were designed to suggest the imposing character of the ancient Roman temples and baths, the impression intended to be made upon the layman approaching the Station, in full view of the exterior of the general waiting room with its huge semi-circular windows, is that of one of the leading railway stations of the world.

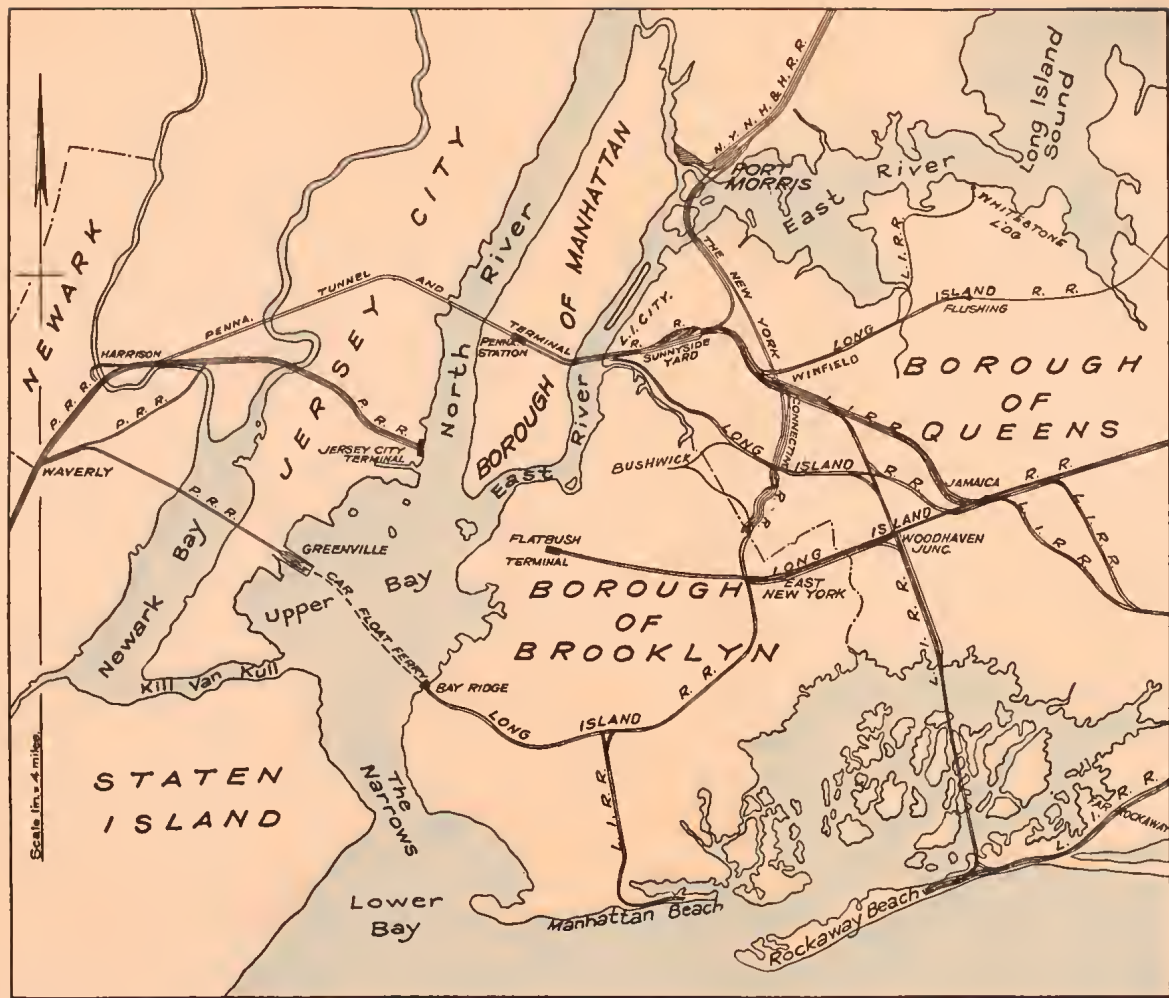
In designing the exterior of the building, Messrs. McKim, Mead & White, the architects, were at pains to embody two ideas: To express in so far as was practicable, with the unusual condition of tracks below the street surface and in spite of the absence of the conventional train shed, not only the exterior design of a great railway station in the generally accepted form, but also to give to the building the character of a monumental gateway and entrance to a great metropolis.

Apart from these two ideas, the plan of the Station was designed to give the greatest number of lines of circulation. The structure is really a monumental bridge over the tracks, with entrances to the streets on the main axis and on all four sides. In this respect the building is unique among the railway stations of the world, affording the maximum of entrance and exit facilities.

The Seventh Avenue facade is composed principally of a Roman Doric colonnade, double at the carriage entrances at the street ends and at the main front entrance for pedestrians in the center; each of the columns is 4 feet 6 inches in diameter and 35 feet high. Above the central colonnade is an entablature surmounted by a clock with a dial 7 feet in diameter. The center of this clock is on the axial line of Thirty-second Street, and 61 feet above the sidewalk.

This Seventh Avenue facade was conceived especially to symbolize in most imposing fashion a monumental gateway. It may be compared, with due allowance for its more massive proportions, to the Brandenburg Gate in Berlin, through which passes so much of the traffic of that city. The central entrance on Seventh Avenue leads to the main waiting room through an arcade 225 feet long by 45 feet wide, flanked on both sides by shops. At the farther end of the arcade are the restaurants, lunch rooms and cafe, and beyond are the general waiting room and concourse, the latter being on the first level below the street.

The main body of the building approximates in height the Bourse of Paris, reaching 76 feet above the street level. With entrances through the two corners of the Station on Seventh Avenue there are carriage drives, each about 63 feet wide, or almost twice the





width of a standard New York City street, fronted by double columns and pediments. The narrowest opening between the columns is practically equal in width to the arched driveways in the Louvre, through which the omnibuses of Paris pass. The frontage is the same on Thirty-first and Thirty-third Streets. The walls of the exterior of the carriage drives are of pilaster treatment for a distance of some 279 feet.

The central features of the facades of the Thirty-first and Thirty-third Street sides for a distance of about 230 feet are formed by a colonnade opening into the carriage driveways below. Over the central porticos of these colonnades are ornamental clocks and eagles, similar to those in the Seventh Avenue front. From the opening in the center, bridges for the use of foot passengers entering from the street level lead directly over the carriage driveways to the general waiting room. West of these carriage courts, and along the Eighth Avenue front, the general scheme of design is continued by the use of pilasters in place of columns, except at the three entrances to the concourse and offices. This entire section of the building is composed of four stories of offices given over to the use of the local executive staff of the Railroad Company.

The Eighth Avenue frontage is treated on the plan of pilasters except for 44 feet 6 inches; this part

is broken by columns into intervals of three spaces to mark another spacious entrance to the main floor of the concourse.

One of the distinctive features of this building is the waiting room, which extends from Thirty-first to Thirty-third Streets, its walls parallel to Seventh and Eighth Avenues for a distance of 314 feet 4 inches. The height of this room is 150 feet and its width 108 feet 8 inches. The walls of the waiting room above the main body of the building contain on each side three semi-circular windows of a radius of 33 feet 4 inches, and 66 feet 8 inches wide at the base. There is also a window of like size at each end of the waiting room.

The dignified design of the interior of the waiting room, while fully adapted to modern ideas, was suggested by the great halls and basilicas of Rome, such as the baths of Caracalla, Titus and Diocletian, and the basilica of Constantine, which are perhaps the greatest examples in history of large roofed-in areas treated in a monumental manner.

The main waiting room on the concourse level is the largest in the world. Within its walls are located the ticket offices, baggage checking windows, and telephone and telegraph offices, so conveniently arranged that a passenger may proceed from one to the other with a minimum amount of exertion and without retracing his steps. Adjoining the general waiting room on the west side are waiting rooms,



*Pennsylvania Station—*

*The Arcade, looking from the  
Seventh Avenue Entrance  
toward the Main Waiting Room*



*Pennsylvania Station—  
Arcade Entrance to Loggia  
and Main Waiting Room*

each 58 by 100 feet, for men and women. These open into retiring rooms.

The grand stairway, 39 feet 6 inches wide, is constructed of Italian "Travertine" stone. It leads from the arcade into the general waiting room, and from it one gets a view of the main entrance to the arcade and of the entire waiting room. At the head of this stairway, in the Travertine wall is placed the statue of Alexander Johnston Cassatt, the dominant personality in the Pennsylvania Railroad tunnel and station project. No greater tribute could be paid to his genius than the inscription at the base of the statue, which reads as follows:

ALEXANDER JOHNSTON CASSATT

PRESIDENT PENNSYLVANIA RAILROAD COMPANY

1899

1906

WHOSE FORESIGHT, COURAGE AND ABILITY

ACHIEVED THE EXTENSION OF THE

PENNSYLVANIA RAILROAD SYSTEM INTO

NEW YORK CITY

The statue is the work of Adolph Alexander Weinman, the sculptor.

The Roman Travertine used in the arcade and general waiting room of the Station for the walls, and for all columns, pilasters and stairways, comes

from the quarries in the Roman Campagna, near Tivoli, Italy. It is the stone of which imperial and modern Rome is principally built, these quarries having supplied the major part of the building stone of Rome for many centuries. Notable examples of its use are the Coliseum and St. Peter's Cathedral. It was imported into this country for the first time by the Pennsylvania Railroad Company for use in the Pennsylvania Station in New York.

Travertine stone was used in the construction of the Station for the reason that while it is very hard and durable, it has an openness of texture which makes it particularly suitable for use in areas of such unusual dimensions as the Pennsylvania Station, giving a character and distinction to the surface which could not be obtained with a stone of more uniform appearance. Moreover, the stone tends to take a polish when rubbed up against rather than absorb dirt, which makes it very practical for public station uses. Its warm, sunny, yellow color is pleasing, and in this respect it is distinctly superior to almost any of the stones available in the North American continent, which are, as a rule, of a cold gray color. Through the use of this stone, the general waiting room has a mellowness of tone which is very noticeable, even on the cloudiest days.

The main baggage room, with 450 feet of frontage, is located on the same level with the general



*Pennsylvania Station—*

*Corner of Loggia at the head of  
Grand Stairway, looking through  
the Arcade to Seventh Avenue*



*Pennsylvania Station—  
General View of Main Waiting  
Room*

waiting room. This is for inbound and outbound baggage carried by cabs and transfer wagons, and covers the full area occupied by the arcade and restaurants on the plane above. Baggage is delivered to and taken from trains through a special subway. From the baggage room trunks are delivered to the tracks below by motor trucks and elevators. Motor cabs will also be stationed on this level.

Parallel to and connected with the main waiting room by a wide thoroughfare is the concourse, a covered assembling place over 200 feet wide, extending the entire width of the Station, and under Thirty-first and Thirty-third Streets. It is directly over the tracks on which the trains arrive and depart. The concourse is the vestibule to the tracks; stairs descend from it to each of the train platforms. All of this area is open to the tracks, forming a courtyard 340 feet wide by 210 feet broad, roofed by a lofty dome of iron and glass. In this dome the architects have attempted to give a simple architectural expression to structural steel without the use of ornament. This has been done considerably abroad, notably in the railway stations at Frankfort and Dresden, Germany, but it has never before been attempted in this country. The design, which involves intersecting arched vaults, is, from a structural view, distinctly more complicated than the European examples cited.

In addition to the entrances to the concourse from the waiting room, and from Eighth Avenue, there are direct approaches from the two side streets. Midway in the block between Seventh and Eighth Avenues and opposite the entrance to the Station on Thirty-third Street, is a wide private street, which affords direct communication with Thirty-fourth Street, an important crosstown thoroughfare. Leading up from the exit concourse of the Station to this private street is a moving stairway.

Underlying the main concourse and located between it and the tracks is the exit concourse, 60 feet wide, which will be used for egress purposes only. This exit concourse is eighteen feet above the train platforms and is connected with them by two stairways and one elevator from each platform. From the exit concourse ample staircases and inclines lead directly to the two side streets, Thirty-fourth Street and Eighth Avenue. In addition, the Company has arranged for direct connection with subways in Seventh and Eighth Avenues, when these lines are built.

For the first time in this country, a station has been planned in such a way as to provide for the complete separation, above the train platform level, of the incoming and outgoing traffic ; this, to a great extent, should avoid much confusion. The Station is so located and designed that the traffic may enter



*Pennsylvania Station—*

*View of Main Waiting Room,  
looking from Entrance to Con-  
course toward Seventh Avenue,  
showing Grand Stairway*





*Pennsylvania Station—  
Bird's-eye View*



*Pennsylvania Station—*

*Detail of portion of the West  
Wall, Main Waiting Room,  
looking toward Concourse*

or leave the building on any of the four adjoining streets and avenues, and in this manner congestion is avoided.

The northern side of the Station extending along Thirty-third Street is assigned to the Long Island Railroad. Into this part of the Station trains will run from all points on Long Island by way of the East River tunnels. Separate ticket offices, entrances and exits are provided, so that this suburban traffic can be handled independently of the rest of the Station.

The third level for the passenger is the train platform, about thirty-six feet below the surface of the street. This Station is the first one in America in which a trunk line has adopted the raised platform construction, similar to that used in England. The confusion, delay and awkwardness of people entering and leaving railway carriages by the steep steps now in use will be entirely done away with, and the rapid handling of large crowds will be very materially facilitated.

## V

A description of this vast improvement is incomplete without figures showing just how enormous it really is. The area of the Station and yard is twenty-eight acres, and in this there are sixteen miles of track. The storage tracks alone will hold 386 cars. The length of the twenty-one standing tracks at the Station is 21,500 feet. There are eleven passenger

platforms, with twenty-five baggage and express elevators. The highest point of the tracks in the Station is nine feet below sea level.

The station building is 784 feet long and 430 feet wide. The average height above the street is 69 feet, while the maximum is 153 feet. To light the building it will take about 500 electric arcs and 20,000 incandescents.

More than 150,000 cubic yards of concrete were required for the retaining walls, foundations, street bridging and the sub-structure. There are 650 columns supporting the station building and the greatest weight on any one of these is 1658 tons.

The river tunnels leading to the Station are, all told, 6.8 miles long, and the land tunnels have the same length. From the Bergen Hill portal in New Jersey to the Long Island entrance of the tunnels it is 5.3 miles. It is 8.6 miles from Harrison, New Jersey, to the Station in New York, while from the latter point to Jamaica the distance is 11.85 miles.

The maximum capacity in trains per hour of all of the Pennsylvania tunnels is 144, and the proposed initial daily service will consist of about 600 Long Island Railroad trains and 400 Pennsylvania trains.

The stone work of the Station, covering some eight acres of ground, was completed on July 31, 1909. To enclose this vast area has necessitated the



*Pennsylvania Station—*

*Exit to Thirty-third Street from  
Main Waiting Room, showing  
Doors leading to the Driveway*



*Pennsylvania Station—*

*Concourse, looking toward Thirty-  
third Street, showing Train  
Gates and Indicators*

building of exterior walls aggregating 2458 feet—nearly half a mile—in length, and has required 490,000 cubic feet of pink granite. In addition, there have been utilized inside the concourse 60,000 cubic feet of stone. A total of 550,000 cubic feet of “Milford pink granite” have thus been utilized in the construction and ornamentation of this building. It took 1140 freight cars to transport these 47,000 tons of stone from Milford, Mass.

In addition to the granite, the construction of this building has called for the use of 27,000 tons of steel. There have also been set in place some 15,000,000 bricks, weighing a total of 48,000 tons. The first stone of the masonry work on the building was laid June 15, 1908; the entire masonry was thus completed in approximately thirteen months after the work was begun.

## VI

To give a condensed history of the construction of the New York Improvement of the Pennsylvania Railroad, and to record the names of those who have had most to do with the work, the Company, through the Board of Directors, has placed two tablets on the sides of the main entrance to the Station on Seventh Avenue. The tablet on the right as one enters the Station bears the following inscription :

“This tablet is erected by the Board of Directors  
of the Pennsylvania Railroad Company to com-

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## *The Pennsylvania Railroad's New York Improvement*

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memorate the extension of its Railroad System into New York City by the completion and opening on the Eighth day of September, A.D. 1910, of the tunnels and Station, and to record the names of the Directors and Officers who shared the responsibility of authorizing and constructing the undertaking.

The tunnels and Station were planned and constructed under the executive direction and supervision of Alexander Johnston Cassatt, President, and Samuel Rea, Vice-President, of the Companies, incorporated in 1902 in the States of New York and New Jersey, and later merged, constituting the Pennsylvania Tunnel and Terminal Railroad Company.

General Counsel, George V. Massey.

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### BOARD OF ENGINEERS AND CHIEF ENGINEERS

Chairman, General Charles W. Raymond.

Gustav Lindenthal, resigned December 15, 1903.

Chief Engineer, North River Division, Charles M. Jacobs.

Chief Engineer, East River Division, Alfred Noble.

Chief Engineer, Electric Traction and Station Construction, George Gibbs.

Chief Engineer, Meadows Division, William H. Brown, retired March 1, 1906, succeeded as Chief Engineer by Alexander C. Shand.

Architects, New York Station, McKim, Mead & White.



*Pennsylvania Station—*

*Concourse, showing detail of  
one of the Exits to Thirty-  
third Street*



*Pennsylvania Station—*

*Track Level, showing Stairways  
and Elevators leading to Exit  
Concourse*

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## *The Pennsylvania Railroad's New York Improvement*

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### BOARD OF DIRECTORS OF THE PENNSYLVANIA RAIL- ROAD COMPANY

Alexander Johnston Cassatt, President, died December 28, 1906.

Sutherland M. Prevost, Vice-President, died September 30, 1905.

William L. Elkins, died November 7, 1903.

Amos R. Little, died December 16, 1906.

Alexander M. Fox, died October 6, 1907.

John P. Green, Vice-President, retired March 24, 1909.

N. Parker Shortridge, Thomas DeWitt Cuyler,

Clement A. Griscom, Lincoln Godfrey,

William H. Barnes, Rudolph Ellis,

George Wood, Henry C. Frick,

C. Stuart Patterson, Charles E. Ingersoll,

Effingham B. Morris, Percival Roberts, Jr.

W. W. Atterbury, Fifth Vice-President.

Henry Tatnall, Fourth Vice-President.

John B. Thayer, Third Vice-President.

Samuel Rea, Second Vice-President.

Charles E. Pugh, First Vice-President.

James McCrea, President.

Inscribed on the other tablet is the following :

### PENNSYLVANIA TUNNEL AND TERMINAL RAILROAD COMPANY

The franchise from the City of New York authorizing the construction, maintenance and operation of the Tunnel Extension and Station of

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## *The Pennsylvania Railroad's New York Improvement*

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The Pennsylvania Railroad System was granted October 9, 1902, by the

### BOARD OF RAPID TRANSIT RAILROAD COMMISSIONERS

Alexander E. Orr, Chairman.

John Claflin, Edward M. Grout,  
Morris K. Jesup, Woodbury Langdon,  
Charles Stewart Smith, John H. Starin,  
Mayor, Seth Low.

The construction of the Tunnel Extension was begun June 10, 1903. The two tunnels under the North River and the four tunnels under the East River were built by shields driven from each side of the respective rivers, and union was completed by the junction of the last tube on the following dates:

North River Tunnels, October 9, 1906.

East River Tunnels, March 18, 1908.

These were the first tunnels for standard railroad trains constructed under these rivers.

The construction of the New York Station building was begun May 1, 1904, and trains were first operated from it on regular schedule September 8, 1910.

The principal contractors were:

#### *North River Tunnels*

O'Rourke Engineering Construction Company.

#### *East River Tunnels*

S. Pearson & Son, Inc.

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## *The Pennsylvania Railroad's New York Improvement*

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### *Crosstown Tunnels—East River to New York Station*

United Engineering and Contracting Company.

### *New York Station*

Engineers, Steel Structure and Machinery: Westinghouse, Church, Kerr & Co.

Excavation: New York Contracting Company.

Erection: George A. Fuller Company.

### *Bergen Hill Tunnels*

William Bradley.

### *Meadows Division*

McMullen & McDermott.—H. S. Kerbaugh.

Henry Steers, Inc.

### *Sunnyside Yard and Approaches*

Degnon Realty and Terminal Improvement Company.  
Naughton Company and Arthur McMullen.

Erected by the Board of Directors of The Pennsylvania Railroad Company on the Eighth day of September, 1910."

It is impossible to insert in these tablets the names of all those discharging responsible duties on the Tunnel Extension, but the Management fully appreciates and recognizes the ability and fidelity which secured the completion of the work, and especially that displayed by the Assistant Chief Engineers and their staffs engaged in the hazardous as well as unique task of constructing the tunnels under North and East Rivers. Special mention, is, therefore, made of James Forgie and Charles L. Harrison, the Assistant Chief Engineers, respectively, of the North and East

River Tunnels; and also E. R. Hill, Assistant to Chief Engineer of Electric Traction and Station Construction, and E. B. Temple, Assistant Chief Engineer, Meadows Division.

This great work must, however, be regarded as representing the united effort and experience of the Pennsylvania Railroad Organization, and while it would be impracticable to make a complete list of all Officers and employes of the entire system who assisted, it is desirable to mention the following members of the several Committees and others, who co-operated with and assisted the Executives and the Board of Tunnel Engineers in the formulation of designs and plans for the operating, terminal, track, yard, mechanical, electrical and signaling requirements, and in the solution of the important problems necessitated by the scope of improvement project:

Jos. T. Richards, Chief Engineer Maintenance of Way, as Chairman of various Committees on operating, track and yard work requisites; Theo. N. Ely, Chief of Motive Power, as Chairman of the Mechanical and Electrical Advisory Committee, W. Heyward Myers, General Manager, F. L. Sheppard, General Superintendent, New Jersey Division; Benj. W. Carskaddon, Real Estate Agent; J. R. Wood, Passenger Traffic Manager; D. S. Newhall, Purchasing Agent; R. Trimble, Chief Engineer Maintenance of Way, Northwest System, Lines West; W. C.



*Pennsylvania Station—*

*Exit Concourse, showing one of  
the Exit Elevators, and Stairway  
leading to Thirty-third Street*



*Pennsylvania Station—*

*Driveway on Thirty-first Street  
side, looking from Entrance to  
Concourse toward Seventh  
Avenue. The Overhead Bridge  
leads directly into the Main  
Waiting Room*

Cushing, Chief Engineer Maintenance of Way, Southwest System, Lines West; A. W. Gibbs, General Superintendent of Motive Power; D. F. Crawford, General Superintendent of Motive Power, Lines West; Chas. M. Sheaffer, Superintendent Passenger Transportation; R. M. Patterson, Superintendent Freight Transportation; L. R. Zollinger, Engineer Maintenance of Way; Axel S. Vogt, Mechanical Engineer; B. F. Wood, Assistant Engineer, Altoona, Pa.; H. R. Leonard, Engineer of Bridges; A. M. Parker, Principal Assistant Engineer, New Jersey Division; R. L. O'Donnel, General Superintendent, B. & A. V. Division; D. H. Lovell, Superintendent, W. J. & S. R. R. Co.; F. P. Abercrombie, as Superintendent of New York Division; D. C. Stewart, as Superintendent of Telegraph, and J. B. Fisher, who succeeded him in that position; A. H. Rudd, Signal Engineer; L. H. Barker, Principal Assistant Engineer U. R. R. of N. J. Division, and later as Engineer of Construction, Sunnyside Yard; H. C. Booz, Principal Assistant Engineer of Branch Lines; Ralph Peters, President and General Manager and J. A. McCrea, General Superintendent of Long Island R. R. Co.; C. S. Krick, Superintendent and A. J. County, Assistant to President, Pennsylvania Tunnel & Terminal Railroad Company.

## VII

The New York Tunnel Extension of the Penn-

sylvania Railroad running east and west from the New York Station begins at Harrison, New Jersey, a short distance east of Newark. Here is located a transfer yard for the huge electric locomotives used in the tunnels. At this point through passenger trains from Southern and Western points will change from steam to electric power, and passengers whose destination is in the downtown district of New York, may alight here and walk across the transfer platform to an electric train which will run into the Church and Cortlandt Street Station of the Hudson & Manhattan Railroad. This downtown rapid transit electric train starts from a new station on Military Park, in Newark, thence by a new bridge over the Passaic River at Centre Street, to Harrison, where passengers may transfer to trains for the Pennsylvania Station uptown, or continue to Jersey City and lower New York.

The through trains for New York leave Harrison on rails crossing over the old Pennsylvania tracks on a steel and concrete bridge. A double-track elevated line on embankments and bridges extends across the Hackensack Meadows to Bergen Hill, that high eminence which is a continuation of the rocky cliffs extending along the Hudson River. In the western slope of this hill are found the entrances to the tunnels which lead under the North River, into the Station in New York.



*Pennsylvania Tunnels—  
Hackensack Portals of Bergen  
Hill Tunnel in New Jersey*



*Pennsylvania Tunnels—  
Interior, showing Signal Apparatus*

## VIII

The construction of the Pennsylvania Railroad tunnels under the North and East Rivers into New York and New Jersey, attaining a maximum depth of 97 feet below mean high water, and built for a heavy and high-speed traffic of great volume, was an undertaking without precedent.

The tunnels or tubes themselves consist of a series of iron rings, and the installation of every ring meant an advance of two and a half feet. Eleven segments and a key piece at the top complete the circumference, and an entire ring weighs about fifteen tons. The cast-iron plates, or sections of the ring, have flanges at right angles to the surface, and it is through these that the successive rings are held together with bolts. The record progress in one day of eight hours was five of these rings, or twelve and one-half feet. Hydraulic rams, placed against the flanges every few inches around the tube, were used to push forward the huge shields with which the tunnels were bored. This type of shield weighed 194 tons. It had nine doors in it, and through these came the rock, or sand, or silt, or whatever material the tube penetrated.

To insure that the east and west-bound shields would meet exactly, the engineers calculated the difficulties closely, and a really remarkable system of reports was in effect from the first day work was started. Every morning they knew the progress

made in the tunnels the day before, to the very inch, and the amount of rock and soil excavated, to the cubic foot. The Pennsylvania Railroad Officers and the engineers hold this perfect system and the thoroughness of each day's work chiefly responsible for the accuracy of the meeting of the tubes.

Engineers say, too, that no project was ever carried out where emphasis was placed entirely upon the results—strength, safety, permanency—rather than upon the money it cost to attain them.

The shields in the north tube under Hudson River met on September 17, 1906. Each had traveled some 3000 feet through a river bed, yet the meeting was perfect. About a month later the shields in the south tube met in the same way. The shields in the south tube were united by a tunnel section, consisting of eight rings, that had been on exhibition at the St. Louis World's Fair. The shields in the four East River tunnels met as perfectly as those in the Hudson River tubes, and all were completed at about the same time.

When the tubes were through from end to end, the work of putting in the 22-inch concrete lining was started immediately. On each side of the tunnel there is a so-called bench three feet wide, which serves as a walk, and under which are carried conduits for telegraph, telephone, signal and power wires.

## IX

In the construction of the tunnels, nothing was

left undone by the Railroad Company to protect the lives and health of the workmen.

No engineering problem connected with the entire New York Tunnel Extension received more attention than did the many precautions to protect the hundreds of men who, day and night, weekdays, Sundays and holidays, bored the under-river tunnels. Down under many fathoms of mud, gravel and rock the iron tubes which land passengers from the East and West into the heart of New York City were pushed steadily forward with no more waste of time than it took to change the "shifts."

Under-water work has a fearsome sound—to those who have never seen it going on. Talk to men who have been engaged in it for years and you get another idea. There are plenty who can speak with authority, for the world was searched for men of the ripest experience to build the Pennsylvania tunnels. On the crosstown shafts, sixty Austrians, who received their training in the Simplon tunnel, were employed. There were engineers and foremen here who had tunneled in Egypt, South Africa, England and America, and who now are doubtless looking for other subterranean regions to conquer.

## X

To make it as safe under the bed of the river as it is on the land's surface was the aim of the Pennsylvania tunnel builders.

The work was performed so thoroughly and with such skill that the engineers, their assistants, and the laborers have left a permanent monument to the mastery of science over the greatest physical barriers of nature. As a result of the nine years of thought and arduous labor, which made possible the Pennsylvania tunnels and Station, the traveler can now be carried straight into the heart of New York City on tracks encased in tubes of the most substantial construction—tubes which from New Jersey run without a curve to the Manhattan side of the Hudson River. Tubes equally free from curves run from the Station to the East River, under which they shoot almost in a straight line to Long Island.

When the two tracks emerge from the tubes under the Hudson and reach the entrance to the Station yard at Tenth Avenue they begin to spread out. From this point, and extending into the Station, the number grows from two to twenty-one.

The number of tracks leading out of the Station yard to the east gradually decreases from twenty-one to a total of four for the main line. These pass under the city and East River to the Sunnyside Yard on Long Island, the terminus of the tunnel extension, and the point of connection with the Long Island Railroad.

From the Station the Manhattan crosstown twin tunnels, containing four tracks in all, traverse a sec-



*Pennsylvania Tunnels—*

*Two of the Long Island Portals*



*Electric Locomotive—  
Type of Locomotive to be used  
in Pennsylvania Tunnels*

tion of New York City second in importance only to the financial district, and one that includes the larger hotels, retail shops and theaters, and many residences. These tunnels end at the river shaft, situated in the block between Thirty-third and Thirty-fourth Streets east of First Avenue.

## XI

Sunnyside Yard, on Long Island, is to the New York Improvement what the West Philadelphia passenger yard is to the Philadelphia Terminal, or the Jersey City Yard to the Jersey City Station. The new yard has many unique features, however, such as the provision for running all trains around a loop—doing away with the use of turntables—pulling them into the coach-cleaning yard at one end and departing from the other end, thus turning the entire train and avoiding the necessity for switching baggage cars and sleeping cars to opposite ends of the trains and the turning of combination cars separately. The arrangement of tracks on different levels makes provision for cross-over movements without grade crossings and eliminates interference with high-speed traffic.

Sunnyside Yard is 5500 feet long with a maximum width of 1550 feet, embracing some 173 acres of land. It contains 53 miles of tracks which have a capacity of 1387 cars. There is additional space for extend-

ing the trackage of the yard to provide more car standing-room in the future.

From Sunnyside Yard there are tracks leading to the New York Connecting Railroad, which, when constructed, will form a junction with the New York, New Haven & Hartford Railroad at Port Morris, New York. The Connecting Railroad will cross East River by the "Hell Gate" Bridge over Ward's and Randall's Islands.

## XII

In connection with its improvements in and around New York City, the Pennsylvania Railroad Company has constructed at Greenville, N. J., an extensive freight transfer yard. It is the most completely equipped yard for rapid and economic handling of freight. From Greenville cars are transported by floats and delivered to the great piers of New York City. Freight destined to Brooklyn or to other points on Long Island is floated across the bay from Greenville to the opposite shore at Bay Ridge, Long Island. Freight for New England and Eastern points is floated up the East River to the New York, New Haven & Hartford Railroad's Port Morris Station. Later, when the New York Connecting Railroad is constructed, freight will be floated to Bay Ridge and run over Long Island tracks to the Connecting Railroad, and thence to the mainland, where

connection will be made with the New York, New Haven & Hartford Railroad System for Boston and New England points.

### XIII

One of the most important features of the Pennsylvania Railroad's New York Tunnel Extension is its relation to the Long Island Railroad—a subsidiary line of the Pennsylvania.

In addition to the many millions the Pennsylvania Railroad has spent for the four tunnels under the East River, and the vast Station and terminal in Manhattan by which all Long Island will benefit, the Long Island Railroad is increasing its own facilities in all directions to take care of the present large traffic and the larger traffic which will come with the use of the tunnels into the Pennsylvania Station in New York. This will place all parts of Long Island and its many seaside resorts within easy reach of New York City.

Tomorrow, for in the construction of vast railroad improvements years count as but days, the New York Connecting Railroad, crossing the East River on a four-track arch bridge, will be completed, and there will be established the first all-rail service between New England and the West and South by way of New York City.

The skill and experience that has evolved the tunnels and Station will not excel that of the Officers and Employees of the Transportation and Traffic

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*The Pennsylvania Railroad's New York Improvement*

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Departments of the Company, to whom the tunnel extension is now committed for successful operation. The traveler may rest assured that nothing will be left undone to insure his safety, comfort and convenience while on the Pennsylvania System.











